Role of Bromine in Restoring Superconductivity in $YBa_2Cu_3O_y$

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Abstract No. Potr0503
Beamline(s): **X11A**

Introduction: In studies involving the halogenation of YBa_2Cu_3(YBCO), it has been observed that Cl, Br, and I return the lattice of deoxygenated YBCO from the non-superconducting, tetragonal phase to the orthorhombic phase with superconductivity being partially restored[1]. Furthermore, it has been reported that the brominated material has a reduced critical current compared to the fully oxygenated parent compound[2]. Various mechanisms have been proposed by which superconductivity is restored upon haolgenation[3,4,5]. We have resolved the question of the mechanism by which superconductivity is restored by doping with Br. We have combined EXAFS studies with $Cu_{63,65}$ nuclear quadrupole resonance (NQR) to resolve this question.

Methods and Materials: We have studied the Br EXAFS in this material using a Displex refrigerator to enhance the weak fine structure oscillations. We compare these results with results on a $BaBr_2$ standard. We also probe the Cu environment with the NQR technique.

Results: We find that the Br does not enter the lattice substitutionally, but forms nanoscale $BaBr_2$ precipitates. From the combined NQR and EXAFS results, we find that the introduction of Br destroys some of the local YBCO phase, and liberates oxygen[6]. The liberated oxygen is available to re-oxygenate those local regions of YBCO, which have not undergone decomposition. The presence of small regions of decomposition would explain the reduction in critical current in brominated YBCO relative to the parent compound.

Acknowledgments: This work is supported by the U.S. Department of Energy, Office of Basic Energy Sciences, Division of Materials Sciences, under Contract No. DE-AC02-98-CH10886, Department of Energy Grant No. DE-FG05-89-ER45384, AFOSR-SBIR Grant No. F49620-93-C-0010, and Comnnecticut Critical Technologies Grant No. CII(93G049) We are grateful for the assistant of the staff of the X-11 beam line at the NSLS.

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